Alliance
SOURCE TESTING

Source Test Report

Becton-Dickinson Medical
920 East 19th Street
Columbus, Nebraska 68601

Catalytic Oxidizer -
Ethylene Oxide DRE Test

Test Date: July 11, 2018

AST Project No. 2018-0668D

Regulatory Information

Permit No.(s)
Regulatory Citation(s) 40 CFR Part 63, Subpart O

Source Information

Source Name
Sterilization Chamber – Catalytic Oxidizer

Target Parameter(s)
Ethylene Oxide - DRE

Contact Information

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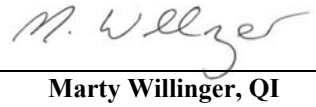
Alliance Source Testing, LLC (AST) has completed the source testing as described in this report. Results apply only to the source tested and operating conditions for the specific test date and time(s) identified within this report. All results are intended to be considered in their entirety, and AST is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts and test data are correct. Data presented in this report have been checked for completeness and are accurate, error-free and legible. Onsite testing was conducted in accordance with approved procedures. Any deviations or problems are detailed in the relevant sections on the test report.

This report is only considered valid once an authorized representative of AST has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.



July 26, 2018

Marty Willinger, QI
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Alliance Source Testing, LLC

Date

July 26, 2018

Kenneth Moody
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Date

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Introduction

1.0 Introduction

Alliance Source Testing, LLC (AST) was retained by Becton-Dickinson Medical (BD Medical) to conduct compliance testing on the ethylene oxide (EO) sterilization chamber at the BD Medical facility located in Columbus, Nebraska. Performance tests were conducted to quantify the concentrations and mass rates of EO into and out of the catalytic oxidizer to determine the EO destruction removal efficiency (DRE) on a mass basis. The performance test was conducted to satisfy testing requirements and demonstrate compliance with emission standards outlined in 40 CFR Part 63, Subpart O – Ethylene Oxide Emissions Standards for Sterilization Facilities. The catalytic oxidizer is required to demonstrate 99% DRE of EO.

1.1 Facility Description/ Source and Control System Descriptions

An EO sterilization chamber is in service at the BD Medical facility in Columbus, Nebraska. A catalytic oxidizer is used for control of EO emissions. The source identification and operating standards are provided in Table 1-1.

Table 1-1
Emission Limits

Source	Pollutant	Citation
Catalytic Oxidizer	Ethylene Oxide DRE ≥ 99% Catalyst bed outlet temperature to be recorded	40 CFR Part 63, Subpart O

1.2 Test Protocol & Notification

Testing was conducted in accordance with the test protocol submitted to NDEQ by BD Medical.

1.3 Test Program Notes

No test method deviations occurred during testing, expect as noted in the test protocol.

At the inlet sampling location, AST did not conduct EPA Method 4 sampling for measuring moisture content, due to the possible EO exposure risks. Moisture content was measured from the outlet sampling location and used for both the inlet and outlet volumetric flow calculations and converting EO concentrations to a dry basis. EPA Method 4 sampling was completed from a single sample point at the outlet sampling location.

EO was not detected at the outlet. An onsite reporting limit of 0.14 parts per million, wet volume basis (ppmvw) was reported for outlet test runs. EO levels detected at outlet were closer to 0.05 ppmvw.

Summary of Results

2.0 Summary of Results

AST conducted compliance testing on the EO sterilization chamber on July 11, 2018.

Three (3), 1-hour test runs will be conducted to determine the concentrations of EO into and out of the sterilization chamber. Concurrent volumetric flow rate (VFR) measurements were conducted to calculate mass rates. Since the contents of the gas streams are is essentially air, a dry molecular weight of 29.0 was assumed for gas velocity calculations. EO DRE was determined by comparing the inlet and outlet EO levels on a mass basis.

Testing involved direct-interface EPA Method 18 on-site gas chromatographs equipped with flame ionization detectors (GCFID) to determine the inlet and outlet levels of EO. The GCFID were calibrated with EO balanced nitrogen standards certified to 2% accuracy and dilutions of certified standards. Due to the presence of methane in the exhaust, a sample of exhaust gas was collected in a Tedlar bag and spiked with a known concentration (50 ppm) of EO to demonstrate adequate EO quantification and recovery.

The involved processes were operating under normal conditions. Applicable operating and control equipment parameters were recorded throughout the test program by BD Medical personnel for inclusion in the test report, including;

- Catalyst bed outlet temperature

Table 2-1 provide a summary of the emission testing results with comparisons to the applicable limits. Any difference between the summary results listed in the following table and the detailed results contained in appendices are due to rounding for presentation.

Table 2-1
Summary of Results

Emissions Data					
Run Number	**1**	**2**	**3**	**Average**	**Emission**
Date	**07/11**	**07/11**	**07/11**	**--**	**Standard**
Operating Data					
Catalyst Bed Outlet Temperature, °C	169.3	185.0	193.1	182.5	
Inlet Data					
H_2O Concentration, %vd	3.4	3.1	2.7	3.1	
VFR, dscfm	4,394	4,216	4,228	4,279	
EO Concentration, ppmvd	680.1	956.9	1,129.1	922.0	
EO Rate, lb/hr	20.48	27.65	32.72	26.95	
Outlet Data					
H_2O Concentration, %vd	3.4	3.1	2.7	3.1	
VFR, dscfm	4,947	4,257	4,255	4,486	
EO Concentration, ppmvd	0.15	0.15	0.15	0.15	
EO Rate, lb/hr	0.005	0.004	0.004	0.005	
DRE Data					
EO DRE (lb/hr), %	99.98	99.98	99.99	99.98	99

Testing Methodology

3.0 Testing Methodology

Testing was conducted in accordance with U.S. Environmental Protection Agency (EPA) Reference Test Methods (RM) 1, 2, 4 and 18 referenced in 40 CFR Part 60, Appendix A. The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control (QA/QC) data are provided in Appendix C.

Table 3-1
Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes
VFR	1-2	Full Velocity Traverses
O_2, CO_2	2	Assumed Ambient
H_2O	4	Gravimetric Analysis
EO	18	Gas Chromatograph

3.1 U.S. EPA Reference Test Methods 1 and 2 – Volumetric Flow Rate

The sampling location and number of traverse points were selected in accordance with EPA RM 1. To determine the minimum number of traverse points, the upstream and downstream distances were equated into equivalent diameters and compared to Figure 1-2 in EPA RM 1. All stack diameters, depths, widths, upstream and downstream disturbance distances and nipple lengths were measured on site with a verification measurement provided by the Field Team Leader.

Full velocity traverses were conducted in accordance with EPA RM 2 to determine the stack gas velocity pressure, static pressure and temperature. The velocity and static pressure measurement system consisted of a pitot tube and inclined manometer. The stack gas temperature was measured with a K-type thermocouple and pyrometer. The pitot assembly was leak checked pre and post each sampling period.

The temperature and differential pressure traverse data were combined with concurrently collected diluent data to calculate the stack gas velocity and volumetric flow rate in units of feet per second (ft/sec), actual cubic feet per minute (acfm), dry standard (1 atmosphere and 68°F) cubic feet per minute (dscfm) and pounds per hour (lb/hr). Since the contents of the gas streams are is essentially air, a dry molecular weight of 29.0 was assumed for gas velocity calculations.

3.2 U.S. EPA Reference Test Method 4 – Moisture Content

The stack gas moisture content was determined in accordance with EPA RM 4.

For each test run, a sample of gas for moisture determination was extracted from the stack at a constant flow rate of no more than 0.75 cubic feet per minute (cfm). The gas sample was passed through a stainless-steel probe, through a series of four (4) chilled glass impingers, and through a calibrated dry gas meter. In lieu of EPA RM 4 Section 8.1.1.1 requirements, a single sample point was used for moisture determination.

Prior to sampling, the first two impingers each were seeded with 100 milliliters of water. The third impinger was empty. The fourth impinger was seeded with 250 grams of dried silica gel. The sampling system was leak checked

pre and post each sampling period. Following sampling, the moisture gain in the impingers was measured gravimetrically and compared to the total sample volume (standard conditions) to determine the moisture content of the gas. The measured moisture content was compared to the saturation moisture content at stack temperature and pressure. The lower of the two moisture content values was reported.

3.3 U.S. EPA Reference Test Method 18 – Ethylene Oxide

Ethylene oxide concentrations were measured in accordance with EPA RM 18 using the direct interface sampling and analysis procedures detailed in the method. Samples were analyzed on-site with an HP Model 5890 Series II Gas Chromatograph equipped with dual RTX-1 columns to separate methane and EO, dual flame ionization detectors (FID) and Chemstation software.

Gas phase calibration standards were prepared by dilution of +/-2% accuracy certified gas standards. Preparation of diluted standards were conducted using a gas-tight volumetric syringe and new Tedlar bags. Triplicate injections were conducted for each standard, and a calibration curve of peak area versus concentration was prepared. A least squares line (y=mx) was fit to the inlet and outlet data set.

Following the GC calibrations, a recovery study (line loss) was conducted using certified EO gas standards with approximate concentrations of 5000 ppm and 50 ppm of EO for the inlet and outlet sampling systems, respectively. A successful recovery study was demonstrated with the mean, triplicate GC response within 10% of the certified gas concentration.

Due to the presence of methane in the exhaust, prior to the test runs as well as during Run 2, a sample of exhaust gas was collected in a Tedlar bag. The contents of EO in the bag was quantified. Then the bag was spiked with a known concentration of EO to demonstrate adequate EO quantification and recovery. EO levels in the exhaust were below the reporting limit of 0.14 ppmvw.

EO levels were measured at the inlet and outlet simultaneously. A gas sample was transported directly to the GC gas sampling valves using a heated sample line. Samples were analyzed approximately once every 10-minutes. A “test run” consisted of five (5) consecutive injections. Three (3), test runs were conducted (for a total of 15 injections) at the inlet and outlet of the catalytic oxidizer.

After completing the 3 test runs, the mid-level calibration standards were re-analyzed at the gas sampling valve in triplicate. The average of the initial calibration response (triplicate average) and the post-test check response (triplicate average) were within 5% of their mean value, and the initial calibration linear regression data were used to quantify EO levels.

The results of the GC analyses were used to calculate EO levels in units of ppmvw. The data were combined with stack gas VFR and H_2O data to calculate EO mass rates in units of pounds per hour (lb/hr) and concentrations in parts per million, dry volume basis (ppmvd). The catalytic oxidizer DRE will be calculated on a mass basis.

Appendix A

Alliance SOURCE TESTING

Location	**Becton-Dickinson Medical**
Source	**Catalytic Oxidizer - Outlet**
Project No.	**18-0668D**
Run No.	**1**
Method	**VFR**

Meter Pressure (Pm), in. Hg

$$Pm = Pb + \frac{\Delta H}{13.6}$$

where,

Pb	28.44	= barometric pressure, in. Hg
ΔH	1.000	= pressure differential of orifice, in H_2O
Pm	28.51	= in. Hg

Absolute Stack Gas Pressure (Ps), in. Hg

$$Ps = Pb + \frac{Pg}{13.6}$$

where,

Pb	28.44	= barometric pressure, in. Hg
Pg	-0.25	= static pressure, in. H_2O
Ps	28.42	= in. Hg

Standard Meter Volume (Vmstd), dscf

$$Vmstd = \frac{17.647 \times Y \times Vm \times Pm}{Tm}$$

where,

Y	1.018	= meter correction factor
Vm	36.820	= meter volume, cf
Pm	28.51	= absolute meter pressure, in. Hg
Tm	551.0	= absolute meter temperature, °R
Vmstd	34.230	= dscf

Standard Wet Volume (Vwstd), scf

$$Vwstd = 0.04707 \times Vlc$$

where,

Vlc	25.9	= volume of H2O collected, ml
Vwstd	1.219	= scf

Moisture Fraction (BWSsat), dimensionless (theoretical at saturated conditions)

$$BWSsat = \frac{10^{6.37 - \left(\frac{2,827}{Ts + 365}\right)}}{Ps}$$

where,

Ts	163.3	= stack temperature, °F
Ps	28.42	= absolute stack gas pressure, in. Hg
BWSsat	0.367	= dimensionless

Moisture Fraction (BWSmsd), dimensionless (measured)

$$BWS = \frac{Vwstd}{(Vwstd + Vmstd)}$$

where,

Vwstd	1.219	= standard wet volume, scf
Vmstd	34.230	= standard meter volume, dscf
BWS	0.034	= dimensionless

Moisture Fraction (BWS), dimensionless

$$BWS = BWSmsd \text{ unless } BWSsat < BWSmsd$$

where,

BWSsat	0.367	= moisture fraction (theoretical at saturated conditions)
BWSmsd	0.034	= moisture fraction (measured)
BWS	0.034	= dimensionless

Molecular Weight (WET) (Ms), lb/lb-mole

$$Ms = Md\ (1 - BWS) + 18\ (BWS)$$

where,

Md	29.00	= molecular weight (DRY), lb/lb mol
BWS	0.034	= moisture fraction, dimensionless
Ms	28.62	= lb/lb mol

Alliance SOURCE TESTING

Location	**Becton-Dickinson Medical**
Source	**Catalytic Oxidizer - Outlet**
Project No.	**18-0668D**
Run No.	**1**
Method	**VFR**

Average Velocity (Vs), ft/sec

$$Vs = 85.49 \times Cp \times (\Delta P^{1/2})\,avg \times \sqrt{\frac{Ts}{Ps \times Ms}}$$

where,

Cp	0.83	= pitot tube coefficient
$\Delta P^{1/2}$	0.565	= velocity head of stack gas, $(in.\ H2O)^{1/2}$
Ts	623.3	= absolute stack temperature, °R
Ps	28.42	= absolute stack gas pressure, in. Hg
Ms	28.62	= molecular weight of stack gas, lb/lb mol
Vs	35.2	= ft/sec

Average Stack Gas Flow at Stack Conditions (Qa), acfm

$$Qa = 60 \times Vs \times As$$

where,

Vs	35.2	= stack gas velocity, ft/sec
As	3.01	= cross-sectional area of stack, ft^2
Qa	6,366	= acfm

Average Stack Gas Flow at Standard Conditions (Qsw), scfm

$$Qsw = 17.647 \times Qa \times \frac{Ps}{Ts}$$

where,

Qa	6,366	= average stack gas flow at stack conditions, acfm
Ps	28.42	= absolute stack gas pressure, in. Hg
Ts	623.3	= absolute stack temperature, °R
Qsw	5,123	= scfm

Average Stack Gas Flow at Standard Conditions (Qsd), dscfm

$$Qsd = 17.647 \times Qa \times (1 - BWS) \times \frac{Ps}{Ts}$$

where,

Qa	6,366	= average stack gas flow at stack conditions, acfm
BWS	0.034	= moisture fraction
Ps	28.42	= absolute stack gas pressure, in. Hg
Ts	623.3	= absolute stack temperature, °R
Qsd	4,947	= dscfm

Dry Gas Meter Calibration Check (Yqa), dimensionless

$$Yqa = \frac{Y - \left(\frac{\Theta}{Vm} \sqrt{\frac{0.0319 \times Tm \times 29}{\Delta H @ \times \left(Pb + \frac{\Delta H\ avg.}{13.6} \right) \times Md}} \sqrt{\Delta H}\ avg. \right)}{Y} \times 100$$

where,

Y	1.018	= meter correction factor, dimensionless
Θ	60	= run time, min.
Vm	36.820	= total meter volume, dcf
Tm	551.0	= absolute meter temperature, °R
ΔH@	1.63	= orifice meter calibration coefficient, in. H_2O
Pb	28.44	= barometric pressure, in. Hg
ΔH avg	1.000	= average pressure differential of orifice, in H_2O
Md	29.00	= molecular weight (DRY), lb/lb mol
$(\Delta H)^{1/2}$	1.000	= average squareroot pressure differential of orifice, $(in.\ H_2O)^{1/2}$
Yqa	1.6	= dimensionless

Location: Columbus Strerilization Plant
Source: Catalytic Oxidizer
Project No.: --
Run 1 Run 1

Ethylene Oxide Mass Rate (ER_{CO}), lb/hr

$$ER_{CO} = \frac{C_{CO} \times MW \times Qs \times 60 \times 28.32}{24.04 \times 1.0E+06 \times 454}$$

where,

C_{CO}	680.1	= EO concentration, ppmvd
MW	44.05	= EO molecular weight, g/g-mole
Qs	4,394	= stack gas volumetric flow rate at standard conditions, dscfm
ER_{CO}	20.48	= lb/hr

Ethylene Oxide Destruction Remvoal Efficiency (RE_{CO}), %

$$RE_{CO} = \left(\frac{C_{COc15I} - C_{COc15}}{C_{COc15I}} \right) \times 100$$

where,

C_{COc15I}	20.48	= EO Inlet Mass Rate, lb/hr
C_{COc15}	0.005	= EO Outlet Mass Rate, lb/hr
RE	99.98	= %

Appendix B

Becton-Dickinson Medical
Columbus, Nebraska
Catalytic Oxidizer
7/11/2018

Field Reference Method Data (Inlet)					
	Run #	**1**	**2**	**3**	**Average**
	Start Time	10:00	11:10	12:20	
	Stop Time	11:00	12:10	13:20	
	Sample Time	60	60	60	

Field Reference Method Data (Outlet)			
1	**2**	**3**	**Average**
10:00	11:10	12:20	
11:00	12:10	13:20	
60	60	60	

Method 18 GC Data (Inlet)					
MW	**Run #**	**1**	**2**	**3**	**Average**
44.05	Ethylene Oxide (ppmvw)	656.68	923.96	1090.30	890.31

Method 18 GC Data (Outlet)			
1	**2**	**3**	**Average**
0.14	*0.14*	*0.14*	0.14

Reference Method Calculations (Inlet)					
	Run #	**1**	**2**	**3**	**Average**
B_{ws}	Moisture Content (%/100)	0.034	0.031	0.027	0.031
F_{DSCFM}	Gas Flow (dscfm)	4,394	4,216	4,228	4,279
ppmvd	Ethylene Oxide (ppmvd)	680.1	956.9	1,129.1	922.0
lb/hr	Ethylene Oxide (lb/hr)	20.48	27.65	32.72	26.95
tpy	Ethylene Oxide (tpy)	89.7	121.1	143.3	118.04
DRE	DRE Ethylene Oxide - lb/hr (%)	99.98	99.98	99.99	99.98

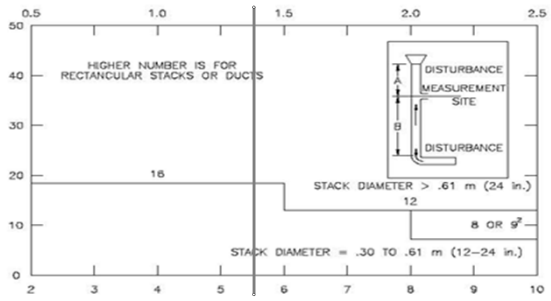
Reference Method Calculations (Outlet)			
1	**2**	**3**	**Average**
0.034	0.031	0.027	0.031
4,947	4,257	4,255	4,486
0.15	0.15	0.15	0.15
0.005	0.004	0.004	0.005
0.02	0.02	0.02	0.02

Method 1 Data

Location Becton-Dickinson Medical
Source Catalytic Oxidizer - Outlet
Project No. 18-0668D
Date: 07/11/18

Stack Parameters

Duct Orientation:	Vertical	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	27.50	in
Nipple Length:	4.25	in
Depth of Duct:	23.50	in
Width of Duct:	--	in
Cross Sectional Area of Duct:	3.01	ft^2
Equivalent Diameter:	--	in
No. of Test Ports:	2	
Distance A:	40.0	ft
Distance A Duct Diameters:	20.4	(must be > 0.5)
Distance B:	10.8	ft
Distance B Duct Diameters:	5.5	(must be > 2)
Minimum Number of Traverse Points:	16	
Actual Number of Traverse Points:	16	



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LOCATION OF TRAVERSE POINTS

Number of traverse points on a diameter

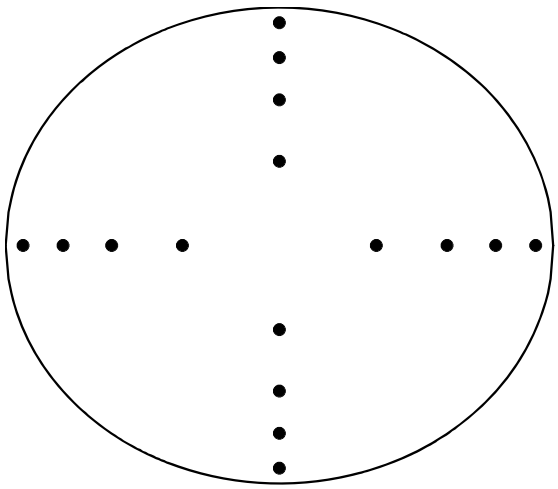
	2	3	4	5	6	7	8	9	10	11	12
1	14.6	--	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	--	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	--	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

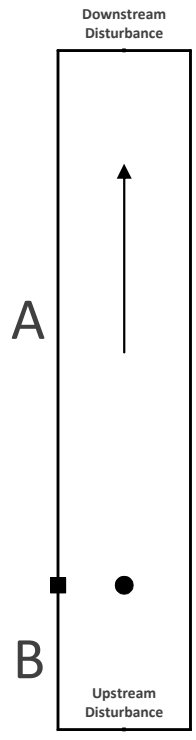
**Percent of stack diameter from inside wall to traverse point.*

Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	3.2	0.75	5.00
2	10.5	2.47	6.72
3	19.4	4.56	8.81
4	32.3	7.59	11.84
5	67.7	15.91	20.16
6	80.6	18.94	23.19
7	89.5	21.03	25.28
8	96.8	22.75	27.00
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = 40 ft.
B = 10.8 ft.
Depth of Duct = 23.5 in.

Cross Sectional Area





Location Becton-Dickinson Medical

Source Catalytic Oxidizer - Outlet

Project No. 18-0668D

Date 7/11/18

Sample Point	Angle (ΔP=0)
1	4
2	3
3	6
4	6
5	9
6	7
7	12
8	10
9	7
10	5
11	8
12	6
13	8
14	9
15	10
16	13
Average	7.7

Location Becton-Dickinson Medical
Source Catalytic Oxidizer - Outlet
Project No. 18-0668D

	Run No.	1		2		3	
	Date	7/11/18		7/11/18		7/11/18	
	Status	VALID		VALID		VALID	
	Start Time	10:05		10:21		12:32	
	Stop Time	10:15		10:34		12:41	
	Leak Check	Pass		Pass		Pass	
Traverse Point		**Δ P (in. WC)**	**Ts (°F)**	**Δ P (in. WC)**	**Ts (°F)**	**Δ P (in. WC)**	**Ts (°F)**
A1		0.22	161	0.20	176	0.21	183
2		0.27	164	0.23	177	0.22	182
3		0.28	165	0.26	178	0.24	183
4		0.31	165	0.27	180	0.26	183
5		0.36	166	0.25	184	0.24	184
6		0.39	165	0.24	184	0.26	184
7		0.36	163	0.25	184	0.25	183
8		0.35	164	0.28	184	0.25	183
B1		0.24	164	0.18	172	0.21	182
2		0.29	164	0.23	178	0.23	183
3		0.32	165	0.25	181	0.25	183
4		0.33	163	0.26	180	0.26	182
5		0.35	162	0.23	180	0.23	183
6		0.36	160	0.24	178	0.25	184
7		0.36	161	0.24	179	0.25	185
8		0.35	160	0.26	179	0.25	185

					Average
Square Root of ΔP, (in. WC)$^{1/2}$	**$(\Delta P)^{1/2}$**	0.565	0.491	0.491	0.516
Average ΔP, in. WC	**(ΔP)**	0.32	0.24	0.24	0.27
Pitot Tube Coefficient	**(Cp)**	0.833	0.833	0.833	0.833
Barometric Pressure, in. Hg	**(Pb)**	28.44	28.44	28.44	28.44
Static Pressure, in. WC	**(Pg)**	-0.25	-0.24	-0.23	-0.24
Stack Pressure, in. Hg	**(Ps)**	28.42	28.42	28.42	28.42
Average Temperature, °F	**(Ts)**	163.3	179.6	183.3	175.4
Average Temperature, °R	**(Ts)**	623.3	639.6	643.3	635.4
Moisture Fraction	**(BWS)**	0.034	0.031	0.027	0.031
Molecuar Weight, lb/lb-mole (dry)	**(Md)**	29.00	29.00	29.00	29.00
Molecuar Weight, lb/lb-mole (wet)	**(Ms)**	28.62	28.66	28.70	28.66
Velocity, ft/sec	**(Vs)**	35.2	31.0	31.0	32.4
VFR at stack conditions, acfm	**(Qa)**	6,366	5,601	5,610	5,859
VFR at standard conditions, scfh	**(Qsw)**	307,404	263,533	262,478	277,805
VFR at standard conditions, scfm	**(Qsw)**	5,123	4,392	4,375	4,630
VFR at standard conditions, dscfm	**(Qsd)**	4,947	4,257	4,255	4,486

Alliance SOURCE TESTING

Location Becton-Dickinson Medical
Source Catalytic Oxidizer - Outlet
Project No. 18-0668D

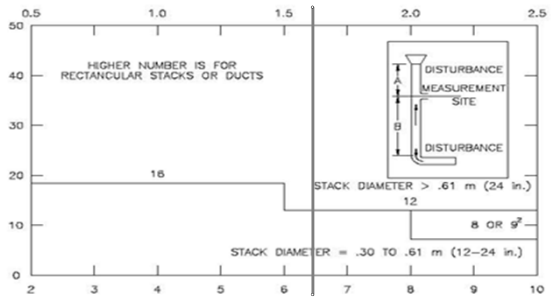
Run No.		**1**	**2**	**3**
Date		7/11/18	7/11/18	7/11/18
Status		VALID	VALID	VALID
Start Time		10:00	11:10	12:20
End Time		11:00	12:10	13:20
Run Time, min	**(θ)**	60	60	60
Meter ID		M5-10	M5-10	M5-10
Meter Correction Factor	**(Y)**	1.018	1.018	1.018
Orifice Calibration Value	**(ΔH @)**	1.630	1.630	1.630
Max Vacuum, in. Hg		4.0	4.0	4.0
Post Leak Check, cfm (at max vac.)		PASS	PASS	PASS
Meter Volume, ft³				
Time		516.458		
0		516.458	553.372	591.000
5		519.500	556.500	594.100
10		522.500	559.600	597.200
15		525.500	562.600	600.300
20		528.600	565.700	603.400
25		531.700	568.800	606.560
30		534.760	572.000	609.800
35		537.800	575.000	612.800
40		540.800	578.100	615.900
45		543.900	581.200	619.000
50		547.000	584.400	622.100
55		550.100	587.500	625.200
60		553.278	590.745	628.407
Total Meter Volume, ft³	**(Vm)**	36.820	37.373	37.407
Temperature, °F				
Time		**Meter / Imp. Exit**	**Meter / Imp. Exit**	**Meter / Imp. Exit**
0		86.0 / 32.0	96.0 / 42.0	101.0 / 46.0
5		85.0 / 40.0	97.0 / 50.0	103.0 / 50.0
10		86.0 / 55.0	98.0 / 54.0	103.0 / 51.0
15		87.0 / 58.0	99.0 / 54.0	104.0 / 52.0
20		88.0 / 58.0	100.0 / 55.0	104.0 / 52.0
25		89.0 / 59.0	100.0 / 55.0	104.0 / 52.0
30		90.0 / 59.0	101.0 / 56.0	105.0 / 51.0
35		93.0 / 57.0	101.0 / 55.0	105.0 / 50.0
40		94.0 / 60.0	102.0 / 57.0	106.0 / 48.0
45		95.0 / 61.0	102.0 / 57.0	105.0 / 47.0
50		96.0 / 60.0	103.0 / 58.0	106.0 / 48.0
55		97.0 / 61.0	103.0 / 59.0	105.0 / 47.0
60		97.0 / 60.0	103.0 / 59.0	105.0 / 48.0
Average Meter Temperature, °F	**(Tm)**	91.0 / --	100.4 / --	104.3 / --
Average Meter Temperature, °R	**(Tm)**	551.0 / --	560.4 / --	564.3 / --
Barometeric Pressure, in. Hg	**(Pb)**	28.44	28.44	28.44
Meter Orifice Pressure , in. WC	**(ΔH)**	1.000	1.000	1.000
Meter Pressure, in. Hg	**(Pm)**	28.51	28.51	28.51
Standard Meter Volume, ft³	**(Vmstd)**	34.230	34.162	33.955
Impinger 1, Pre/Post Test, mL		462.4 / 475.0	475.0 / 488.0	488.0 / 499.6
Impinger 2, Pre/Post Test, mL		453.0 / 456.8	456.8 / 459.6	459.6 / 462.5
Impinger 3, Pre/Post Test, mL		300.4 / 302.9	301.5 / 302.7	300.4 / 301.1
Impinger 4, Pre/Post Test, g		502.9 / 509.9	509.9 / 516.0	516.0 / 521.1
Volume Water Collected, mL	**(Vlc)**	25.9	23.1	20.3
Standard Water Volume, ft³	**(Vwstd)**	1.219	1.087	0.956
Moisture Fraction Measured	**(BWSmsd)**	0.034	0.031	0.027
Moisture Fraction @ Saturation	**(BWSsat)**	0.367	0.532	0.575
Moisture Fraction, unitless	**(BWS)**	0.034	0.031	0.027
DGM Calibration Check Value	**(Yqa)**	1.6	2.2	1.9

Method 1 Data

Location Becton-Dickinson Medical
Source Catalytic Oxidizer - Inlet
Project No. 18-0668D
Date: 07/11/18

Stack Parameters

Duct Orientation:	Horizontal	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	27.50	in
Nipple Length:	4.75	in
Depth of Duct:	23.25	in
Width of Duct:	--	in
Cross Sectional Area of Duct:	2.95	ft^2
Equivalent Diameter:	--	in
No. of Test Ports:	2	
Distance A:	5.4	ft
Distance A Duct Diameters:	2.8	(must be > 0.5)
Distance B:	12.5	ft
Distance B Duct Diameters:	6.5	(must be > 2)
Minimum Number of Traverse Points:	12	
Actual Number of Traverse Points:	16	



CIRCULAR DUCT

LOCATION OF TRAVERSE POINTS

Number of traverse points on a diameter

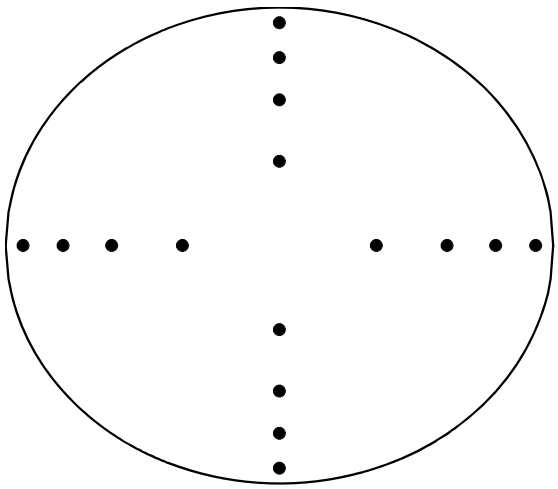
	2	3	4	5	6	7	8	9	10	11	12
1	14.6	--	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	--	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	--	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

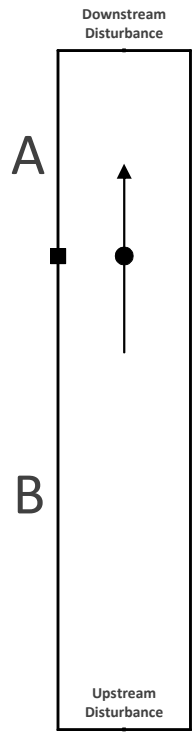
**Percent of stack diameter from inside wall to traverse point.*

Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	3.2	0.74	5.49
2	10.5	2.44	7.19
3	19.4	4.51	9.26
4	32.3	7.51	12.26
5	67.7	15.74	20.49
6	80.6	18.74	23.49
7	89.5	20.81	25.56
8	96.8	22.51	27.26
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = 5.42 ft.
B = 12.5 ft.
Depth of Duct = 23.25 in.

Cross Sectional Area





Location Becton-Dickinson Medical

Source Catalytic Oxidizer - Inlet

Project No. 18-0668D

Date 7/11/18

Sample Point	Angle (ΔP=0)
1	3
2	4
3	7
4	6
5	9
6	11
7	12
8	14
9	5
10	6
11	5
12	7
13	8
14	4
15	6
16	5
Average	7.0

Location Becton-Dickinson Medical
Source Catalytic Oxidizer - Inlet
Project No. 18-0668D

	Run No.	1		2		3	
	Date	7/11/18		7/11/18		7/11/18	
	Status	VALID		VALID		VALID	
	Start Time	10:45		11:51		12:43	
	Stop Time	10:56		11:59		12:51	
	Leak Check	Pass		Pass		Pass	
Traverse Point		**Δ P (in. WC)**	**Ts (°F)**	**Δ P (in. WC)**	**Ts (°F)**	**Δ P (in. WC)**	**Ts (°F)**
A1		0.20	93	0.22	102	0.22	99
2		0.23	94	0.23	101	0.20	101
3		0.25	94	0.23	101	0.23	102
4		0.25	94	0.22	101	0.22	102
5		0.24	94	0.22	100	0.21	101
6		0.24	93	0.23	100	0.22	101
7		0.26	93	0.21	99	0.23	100
8		0.23	93	0.17	97	0.18	97
B1		0.21	93	0.20	100	0.21	99
2		0.24	93	0.22	100	0.23	100
3		0.26	93	0.24	100	0.24	100
4		0.24	93	0.23	100	0.22	101
5		0.25	93	0.23	101	0.24	101
6		0.24	94	0.24	103	0.23	102
7		0.25	94	0.22	102	0.22	102
8		0.22	94	0.22	102	0.23	102

					Average
Square Root of ΔP, (in. WC)$^{1/2}$	**$(\Delta P)^{1/2}$**	0.488	0.469	0.469	0.475
Average ΔP, in. WC	**(ΔP)**	0.24	0.22	0.22	0.23
Pitot Tube Coefficient	**(Cp)**	0.833	0.833	0.833	0.833
Barometric Pressure, in. Hg	**(Pb)**	28.44	28.44	28.44	28.44
Static Pressure, in. WC	**(Pg)**	-7.30	-7.00	-7.20	-7.17
Stack Pressure, in. Hg	**(Ps)**	27.90	27.93	27.91	27.91
Average Temperature, °F	**(Ts)**	93.4	100.6	100.6	98.2
Average Temperature, °R	**(Ts)**	553.4	560.6	560.6	558.2
Moisture Fraction	**(BWS)**	0.034	0.031	0.027	0.031
Molecuar Weight, lb/lb-mole (dry)	**(Md)**	29.00	29.00	29.00	29.00
Molecuar Weight, lb/lb-mole (wet)	**(Ms)**	28.62	28.66	28.70	28.66
Velocity, ft/sec	**(Vs)**	28.9	28.0	28.0	28.3
VFR at stack conditions, acfm	**(Qa)**	5,114	4,948	4,947	5,003
VFR at standard conditions, scfh	**(Qsw)**	273,019	261,009	260,793	264,940
VFR at standard conditions, scfm	**(Qsw)**	4,550	4,350	4,347	4,416
VFR at standard conditions, dscfm	**(Qsd)**	4,394	4,216	4,228	4,279

Becton-Dickinson Medical

Catalytic Oxidizer

7/11/2018

EPA Method 18: Determination of Gaseous Organic Compounds using Gas Chromatography

Sample Analysis (Inlet)

Run 1

Cpd	Inj. 1		Inj. 2		Inj. 3		Inj. 4		Inj. 5		Average		
ID	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	ppm
Ethylene Oxide	2.076	1291768.2	2.077	477331.4	2.077	1408321.9	2.078	2018887.9	2.079	2003382	2.078	1439938	**656.68**

Run 2

Cpd	Inj. 1		Inj. 2		Inj. 3		Inj. 4		Inj. 5				
ID	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	ppm
Ethylene Oxide	2.082	1935611.6	2.084	2062107.8	2.085	2523314	2.087	1567394.5	2.087	2041732.7	2.085	2026032	**923.96**

Run 3

Cpd	Inj. 1		Inj. 2		Inj. 3		Inj. 4		Inj. 5		Average		
ID	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	ppm
Ethylene Oxide	2.09	2220462.5	2.088	2557967.3	2.092	1901202.1	2.091	3079176.5	2.091	2195096.5	2.090	2390781	**1090.30**

Sample Analysis (Outlet)

Run 1

Cpd	Inj. 1		Inj. 2		Inj. 3		Inj. 4		Inj. 5		Average		
ID	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	ppm
Ethylene Oxide	2.744	279.278	2.737	139.59	2.747	135.79	2.746	51.2	2.732	64.0	2.741	134	**0.05**

Run 2

Cpd	Inj. 1		Inj. 2		Inj. 3		Inj. 4		Inj. 5		Average		
ID	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	ppm
Ethylene Oxide	2.734	53.43	2.764	74.7	2.738	91.9	2.727	57.82	2.733	132.5	2.739	82	**0.03**

Run 3

Cpd	Inj. 1		Inj. 2		Inj. 3		Inj. 4		Inj. 5		Average		
ID	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	RT	AC	ppm
Ethylene Oxide	2.737	117.9	2.751	109.36	2.764	82.29	2.727	96.82	2.708	106.58	2.737	103	**0.04**

Appendix C

Wind Tunnel Pitot Calibration

S-type Pitot ID:	**P-1103**	Date:	**3-Apr-17**
Standard Pitot ID:	**001**	Personnel:	**DH**
Cp(std):	**0.99**	Cp(actual):	**0.833**
Part Number:	**PPS12-Y-007.5**	P_{bar}(in Hg):	**29.61**
Test Velocity (fps):	**50**	T(°F):	**71**

A-SIDE

ΔP_{std} (in. H_2O)	ΔP_s (in. H_2O)	Cp(s)	Deviation*
0.547	**0.767**	**0.836**	-0.002
0.548	**0.759**	**0.841**	0.003
0.549	**0.764**	**0.839**	0.001
0.545	**0.766**	**0.835**	-0.003
	AVERAGE	**0.838**	0.002
		Std deviation	0.003

B-SIDE

ΔP_{std} (in. H_2O)	ΔP_s (in. H_2O)	Cp(s)	Deviation*
0.547	**0.784**	**0.828**	-0.001
0.547	**0.781**	**0.829**	0.000
0.548	**0.782**	**0.829**	0.000
0.551	**0.782**	**0.831**	0.002
	AVERAGE	**0.829**	0.001
		Std deviation	0.001

$$Cp(s) = Cp(std)\sqrt{\frac{\Delta P(std)}{\Delta P(s)}}$$

Cp(A) - Cp(B) = 0.009 {must be <0.010}

*Deviation = {Cp(s) - *AVG* Cp(s)} {must be <0.010}

Standard deviation of the deviations must be less than 0.02 for both sides.

Pitot tube S/N P-1103 was calibrated in accordance with the CFR 40, Part 60 Appendix A, Method 2, Section 10.

David Hess
Signature

4/3/17
Date

METHOD 5 DRY GAS METER CALIBRATION USING CRITICAL ORIFICES

1) Select three critical orifices to calibrate the dry gas meter which bracket the expected operating range.
2) Record barometric pressure before and after calibration procedure.
3) Run at tested vacuum (from Orifice Calibration Report), for a period of time necessary to achieve a minimum volume of 10 cubic feet Vcr (STD). K' factors of~.8025 = 13 minutes, .5011 = 20 minutes, .3433 = 30 minutes
4) Record data and information in the **GREEN** cells, YELLOW cells are calculated.

	INITIAL		FINAL	AVG (P_{bar})
BAROMETRIC PRESSURE (mbar):	837	##	837	837

				INITIAL	FINAL	AVG (P_{bar})
DATE:	6/27/2018	DGM SERIAL NUMBER:	18654628	BAROMETRIC PRESSURE (in Hg):	24.71661	24.7166	24.71661
METER PART #:	NA	CRITICAL ORIFICE MFG:	Apex				
		METHOD 5 BOX ID:	M5-10	TECHNICIAN/OPERATOR:	Phil Brock		

ORIFICE #	RUN #	K' FACTOR (AVG)	TESTED VACUUM (in Hg)	DGM READINGS (FT^3) INITIAL	DGM READINGS (FT^3) FINAL	DGM READINGS (FT^3) NET (V_m)	TEMPERATURES °F AMBIENT	DGM INLET INITIAL	DGM INLET FINAL	DGM OUTLET INITIAL	DGM OUTLET FINAL	DGM AVG	ELAPSED TIME (MIN) θ	DGM ΔH (in H_2O)	(1) V_m (STD)	(2) V_{cr} (STD)	(3) Y	$\Delta H_@$
48	1	0.3433	20.0	450.0	460.508	10.508	76	77	78	76	77	77	24.00	0.45	8.5480	8.7987	1.029	1.53
	2	0.3433	20.0	460.508	471.046	10.538	77	78	78	77	78	77.75	24.00	0.45	8.5605	8.7905	1.027	1.53
	3	0.3433	20.0	471.046	481.610	10.564	77	78	76	78	76	77	24.00	0.45	8.5936	8.7905	1.023	1.53
																AVG =	1.026	
63	1	0.5849	17.5	418.001	428.483	10.482	75	74	75	72	74	73.75	14.00	1.40	8.6030	8.7528	1.017	1.65
	2	0.5849	17.5	428.483	438.956	10.473	76	75	76	74	75	75	14.00	1.40	8.5755	8.7446	1.020	1.65
	3	0.5849	17.5	438.956	449.467	10.511	76	76	77	75	75	75.75	14.00	1.40	8.5946	8.7446	1.017	1.65
																AVG =	1.018	
73	1	0.8025	15.5	482.004	493.450	11.446	76	75	75	75	75	75	11.00	2.70	9.4084	9.4269	1.002	1.70
	2	0.8025	15.5	493.450	504.817	11.367	75	75	76	75	75	75.25	11.00	2.70	9.3390	9.4357	1.010	1.70
	3	0.8025	15.5	504.817	516.157	11.340	76	76	78	75	76	76.25	11.00	2.70	9.2995	9.4269	1.014	1.70
																AVG =	1.009	

USING THE CRITICAL ORIFICES AS CALIBRATION STANDARDS:
The following equations are used to calculate the standard volumes of air passed through the DGM, V_m (std), and the critical orifice, V_{cr} (std), and the DGM calibration factor, Y. These equations are automatically calculated in the spreadsheet above.

AVERAGE DRY GAS METER CALIBRATION FACTOR, Y = 1.018

AVERAGE $\Delta H_@$ = 1.63

(1) $$Vm_{(std)} = K_1 * Vm * \frac{Pbar + (\Delta H / 13.6)}{Tm}$$

= Net volume of gas sample passed through DGM, corrected to standard conditions
K_1 = 17.64 °R/in. Hg (English), 0.3858 °K/mm Hg (Metric)
T_m = Absolute DGM avg. temperature (°R - English, °K - Metric)

(2) $$Vcr_{(std)} = K' * \frac{Pbar * \Theta}{\sqrt{Tamb}}$$

= Volume of gas sample passed through the critical orifice, corrected to standard conditions
T_{amb} = Absolute ambient temperature (°R - English, °K - Metric)
K' = Average K' factor from Critical Orifice Calibration

(3) $$Y = \frac{Vcr_{(std)}}{Vm_{(std)}}$$

= DGM calibration factor

$$\Delta H_@ = \left(\frac{0.75\,\theta}{V_{cr(std)}}\right)^2 \Delta H \left(\frac{V_m(std)}{V_m}\right)$$

Pyrometer Calibration Data

Calibration Temp. Reading (F)	Pyrometer Reading (F)	ABS (Relative Difference) % R
0	1	0.2
50	49	0.2
100	99	0.2
150	149	0.2
250	251	0.1
500	499	0.1
800	802	0.2
Max Absolute Difference %.....		0.2

Omega Temp Calibrator ID 1
Omega Temp Calibrator S/N... T-197197
Calibration Date..... 7/27/2017
Recert Date..... 7/27/2018

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	AIR LIQUIDE POLLUTION INC		
Part Number:	X02NI99C15A5263	Reference Number:	126-400855163-1
Cylinder Number:	ALM-014712	Cylinder Volume:	144.4 CF
Laboratory:	124 - La Porte Mix - TX	Cylinder Pressure:	2015 PSIG
Analysis Date:	Feb 15, 2017	Valve Outlet:	350
Lot Number:	126-400855163-1		

Expiration Date: Feb 15, 2019

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
ETHYLENE OXIDE	50.00 PPM	50.02 PPM	+/- 2%
NITROGEN	Balance		

Notes:

AIR LIQUIDE POLLUTION INC
PO#: D0OFC
PO#: 4510145652

Signature on file

Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: CERTIFIED STANDARD-SPEC

Customer:	AIR LIQUIDE POLLUTION INC		
Part Number:	X02NI99C15A0631	Reference Number:	126-400855162-1
Cylinder Number:	ALM013685	Cylinder Volume:	144.9 CF
Laboratory:	124 - La Porte Mix - TX	Cylinder Pressure:	2015 PSIG
Analysis Date:	Feb 15, 2017	Valve Outlet:	350
Lot Number:	126-400855162-1		

Expiration Date: Feb 15, 2019

Product composition verified by direct comparison to calibration standards traceable to N.I.S.T. weights and/or N.I.S.T. Gas Mixture reference materials.

ANALYTICAL RESULTS

Component	Req Conc	Actual Concentration (Mole %)	Analytical Uncertainty
ETHYLENE OXIDE	5210 PPM	5222 PPM	+/- 2%
NITROGEN	Balance		

Notes:

AIR LIQUIDE POLLUTION INC
PO#: D0OFC
PO#: 4510145652

Signature on file

Approved for Release

Location Becton-Dickinson Medical
Source Catalytic Oxidizer - Outlet
Project No. 18-0668D
Parameter VFR

Date	Pitot ID	Evidence of damage?	Evidence of mis-alignment?	Calibration or Repair required?
7/11/18	P-1103	no	no	no
Date	**Barometric Pressure**	**Evidence of damage?**	**Reading Verified**	**Calibration or Repair required?**
7/11/18	Weather Station	NA	NA	NA

Becton-Dickinson Medical

Catalytic Oxidizer

7/10/2018

EPA Method 18: Determination of Gaseous Organic Compounds using Gas Chromatography

Initial Three-Point Calibration

(Inlet) High Level Calibration Standard

Cpd ID	Conc. (ppm)	Inj. 1 RT	Inj. 1 AC	Inj. 2 RT	Inj. 2 AC	Inj. 3 RT	Inj. 3 AC	Average RT	Average AC	OK?
Ethylene Oxide	**5222.00**	2.055	11592055.0	2.056	11610124.0	2.058	10970216.0	2.056	11390798	Y

Mid-Level Calibration Standard

Cpd ID	Conc. (ppm)	Inj. 1 RT	Inj. 1 AC	Inj. 2 RT	Inj. 2 AC	Inj. 3 RT	Inj. 3 AC	Average RT	Average AC	OK?
Ethylene Oxide	**2611.00**	2.059	5862940.0	2.06	5875961.5	2.061	5843135.0	2.060	5860679	Y

Low-Level Calibration Standard

Cpd ID	Conc. (ppm)	Inj. 1 RT	Sig.20015 AC	Inj. 2 RT	Sig.20016 AC	Inj. 3 RT	Sig.20017 AC	Average RT	Average AC	OK?
Ethylene Oxide	**652.75**	2.063	1360158.6	2.063	1357636.1	2.065	1327310.4	2.064	1348368	Y

Initial Three-Point Calibration

(Outlet) Low Level Calibration Standard

Cpd ID	Conc. (ppm)	Inj. 1 RT	Inj. 1 AC	Inj. 2 RT	Inj. 2 AC	Inj. 3 RT	Inj. 3 AC	Average RT	Average AC	OK?
Ethylene Oxide	**50.20**	2.835	137098.9	2.834	134495	2.833	134893.3	2.834	135496	Y

Mid-Level Calibration Standard

Cpd ID	Conc. (ppm)	Inj. 1 RT	Inj. 1 AC	Inj. 2 RT	Inj. 2 AC	Inj. 3 RT	Inj. 3 AC	Average RT	Average AC	OK?
Ethylene Oxide	**25.10**	2.831	69592.3	2.828	69026.3	2.828	69224.8	2.829	69281	Y

Low-Level Calibration Standard

Cpd ID	Conc. (ppm)	Inj. 1 RT	Inj. 1 AC	Inj. 2 RT	Inj. 2 AC	Inj. 3 RT	Inj. 3 AC	Average RT	Average AC	OK?
Ethylene Oxide	**10.04**	2.823	27865.7	2.82	28054.3	2.817	27607.4	2.820	27842	Y

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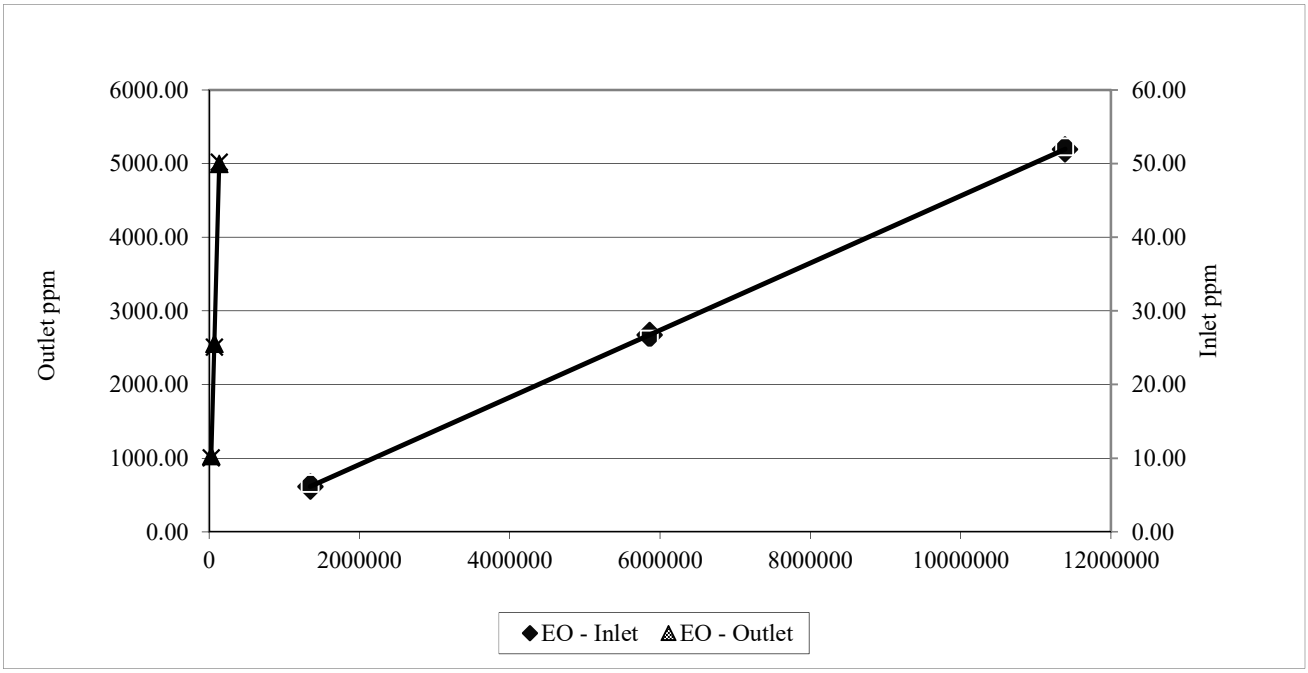
7/10/2018

EPA Method 18: Determination of Gaseous Organic Compounds using Gas Chromatography

Linear Regression Calculations

EO - Inlet				
Certified ppm	**Average AC**	**Linear Regression Statistics**		**ppm from curve**
5222.00	11390798	**R^2**	**M**	5194.72
2611.00	5860679	0.9994	0.00045604	2672.73
652.75	1348368			614.92

EO - Outlet				
Certified ppm	**Average AC**	**Linear Regression Statistics**		**ppm from curve**
50.20	135496	**R^2**	**M**	49.93
25.10	69281	0.9999	0.00036853	25.53
10.04	27842			10.26



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EPA Method 18: Determination of Gaseous Organic Compounds using Gas Chromatography

Quality Assurance Inlet												
Inlet Line Loss Check (High-level calibration gas to the sample probe)												
Cpd ID	Conc. (ppm)	Inj. 1 RT	Sig. 10059 AC	Inj. 2 RT	Sig. 10060 AC	Inj. 3 RT	Sig.10061 AC	Average RT	AC	ppm	Triplicate OK?	Recovery OK?
Ethylene Oxide	**5222.00**	2.074	10710042	2.072	10817854	2.072	10788828	2.073	10772241	4912.63	Y	Y

Inlet Post Test Calibration Check (mid-level calibration gas to the gas sampling valve)												
Cpd ID	Conc. (ppm)	Inj. 1 RT	AC	Inj. 2 RT	AC	Inj. 3 RT	AC	Average RT	AC	ppm	Triplicate OK?	Pre/Post OK?
Ethylene Oxide	**2611.00**	2.096	5525176.0	2.098	5464539.0	2.092	5833090.5	2.095	5607602	2557.32	Y	Y

Run #2 Unspiked Bag Inlet												
Cpd ID	Conc. (ppm)	Inj. 1 RT	AC	Inj. 2 RT	AC	Inj. 3 RT	AC	Average RT	AC	ppm	Triplicate OK?	Recovery OK?
Ethylene Oxide	**Unkown**	2.082	2153093.3	2.081	2103305.2	2.081	2158600	2.081	2138333	975.18	Y	

Post Test Spike Check (50:50 high-level calibration gas and Run #2)												
Cpd ID	Target Conc. (ppm)	Inj. 1 RT	AC	Inj. 2 RT	AC	Inj. 3 RT	AC	Average RT	AC	ppm	Triplicate OK?	Spike OK?
Ethylene Oxide	**3098.59**	2.078	6369979.5	2.078	6313084	2.078	6307601.5	2.078	6330222	2886.87	Y	Y

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Catalytic Oxidizer

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EPA Method 18: Determination of Gaseous Organic Compounds using Gas Chromatography

Quality Assurance Outlet												
Outlet Line Loss Check (High-level calibration gas to the sample probe)												
Cpd ID	Conc. (ppm)	Inj. 1 RT	Sig.20059 AC	Inj. 2 RT	Sig. 20060 AC	Inj. 3 RT	Sig.20061 AC	Average RT	AC	ppm	Triplicate OK?	Recovery OK?
Ethylene Oxide	**50.20**	2.738	126166.6	2.746	126469.3	2.744	124657.2	2.743	125764	46.35	Y	Y

Outlet Post Test Calibration Check (mid-level calibration gas to the gas sampling valve)												
Cpd ID	Conc. (ppm)	Inj. 1 RT	Sig.10043 AC	Inj. 2 RT	Sig.10044 AC	Inj. 3 RT	Sig.10045 AC	Average RT	AC	ppm	Triplicate OK?	Pre/Post OK?
Ethylene Oxide	**25.10**	2.695	64944.3	2.696	65305.8	2.698	67455.6	2.696	65902	24.29	Y	Y

Run #2 Unspiked Bag Outlet												
Cpd ID	Conc. (ppm)	Inj. 1 RT	AC	Inj. 2 RT	AC	Inj. 3 RT	AC	Average RT	AC	ppm	Triplicate OK?	Recovery OK?
Ethylene Oxide	**Unkown**	2.780	75.1	2.78	10.2	2.780	165.9	2.780	84	0.03		

Post Test Spike Check (50:50 high-level calibration gas and Run #2)												
Cpd ID	Target Conc. (ppm)	Inj. 1 RT	AC	Inj. 2 RT	AC	Inj. 3 RT	AC	Average RT	AC	ppm	Triplicate OK?	Spike OK?
Ethylene Oxide	**25.12**	2.780	63384.6	2.78	63893.9	2.779	63522.2	2.780	63600	23.44	Y	Y

Appendix D

Lesni Stack Pre-Test Data

Date: 11 Jul 18 Recorded By: Daniel T Gaunt

Time	% LEL 30.630	% LEL 30.633	Inlet Bed Temp °C (Control) 25.610	Outlet Bed Temp °C 25.611
940	0.0	0.0	161	160
9:50 AM	0.0	0.0	160	161
10:00 AM	1.20	2.0	160	160
10.10 AM	0.0	0.8	160	160
10:20 AM	1.8	2.3	160	163
10:30 AM	1.8	3.1	159	168
10.40 AM	2.7	3.8	160	172
10:50 AM	2.6	3.3	159	179
11:00 AM	0.0	0.5	161	183
11.10 AM	2.2	3.2	160	186
11.20 AM	2.6	3.2	160	184
11.30 AM	1.2	1.9	160	182
11:40 AM	2.6	3.2	160	186
11:50 AM	2.7	3.3	159	187
12:00 PM	1.8	2.6	161	185
12:10 PM	3.2	3.8	159	188
12:20 PM	3.1	3.9	161	188
12:30 PM	2.8	3.3	160	188
12.40 PM	2.6	3.3	159	189
12:50 PM	3.5	4.3	161	192
1:00 PM	~~5.3~~ 3.3	6.0	161	193
1:10 PM	6.3	5.8	160	194
1:20 PM	2.7	3.7	161	198
1:30 PM	2.9	3.8	162	198
1:40 PM	3.7	4.7	163	200

Post Vac Ch 2

Post Vac Ch 2

Post Vac Ch. 3

Lesni Stack Pre-Test Data

Date: 11 Jul 18 **Recorded By:** Daniel T Gaunt

Time	% LEL 30.630	% LEL 30.633	Inlet Bed Temp °C (Control) 25.610	Outlet Bed Temp °C 25.611
1:50 PM	2.9	3.6	163	201
2:00 PM	4.4	5.3	164	201
2:10 PM	4.0	4.9	165	202
2:20 PM	2.8	3.5	165	203
2:30 PM	3.9	5.0	166	206
2:40 PM	2.4	3.3	168	206
2:50 PM	3.7	4.3	166	203
3:00 PM	4.4	5.3	168	208
3:10 PM	2.9	3.5	168	203
3:20 PM	3.4	4.1	167	206
3:30 PM	3.2	4.3	169	207
3:40 PM	3.8	4.4	168	205
3:50 PM	2.7	3.5	167	203
4:00 PM	3.0	4.0	167	204
4:10 PM	3.3	4.1	166	203

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